How can receptor models be applied to estimate the contribution of different source types to ambient PM concentrations?

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research and development

Science Question

How can receptor models be applied to estimate the contribution of different source types to ambient PM concentrations?

Research Goals

1, Develop receptor models for use by air quality management community to estimate contribution of different source types to ambient PM and thereby support emission control strategy development. Models are based on a Graphical User Interface (GUI) and require no other software or licenses. Models evolve to incorporate latest science.

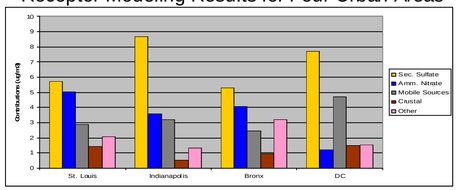
2. Investigate measurements that improve receptor models' abilities to discern and model users' abilities to identify source types. Measurements include general species (e.g. sulfate) at higher time resolution as well as species unique to one or a few source types.

3. Apply receptor models to estimate contributions of separate source types to ambient concentrations and personal exposures.

Methods/Approach

With measurements from existing, national, PM2.5 speciation networks, current receptor models generally resolve 7-10 source types impacting a monitoring location. These broad source types have proved invaluable in understanding which source types are major contributors and have helped to improve source-based models. Bar chart shows modeling results from EPA-funded source apportionment using PMF at 8 urban areas by Coutant, et. al., for data from EPA's Speciation Trends Network for 2001.

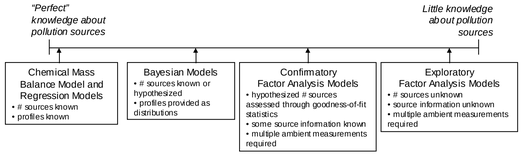
Receptor Modeling Results for Four Urban Areas



- Secondary Sulfate largest source type for all 4 sites.
- Ammonium nitrate second largest source type at all sites, except DC.
- Mobile source type is large source type and has largest contributions at DC.
- Crustal source contributes approximately 1 µg m^{-3} at each site.

Application of the models and interpretation of the source types involves numerous decisions. Recent model enhancements have focused on approaches for guiding these decisions. Enhancements include incorporation of additional information (meteorology, prior knowledge about source profiles or activity patterns). Relationship between receptor models and amount of prior knowledge depicted in graphic to right (adapted by permission from Christensen and Reese STAR grant proposal).

Receptor Modeling Approach –
depends on extent of prior knowledge and objective of analysis



Preliminary Confidence Intervals for Phoenix, 95-98

Source	Ramadan (2000) PMF2	Ramadan (2003) ME2	Lewis (2003) Unmix	Confidence Interval
Motor Vehicle	42%	48%	33%	42-48%
Diesel	6%	6%	16%	0.3-6%
Sec. Sulfate	18%	18%	19%	16-20%
Soil	14%	11%	22%	15-18%
Biomass Burn	13%	13%	10%	7-11%
Sea Salt	0.6%	0.7%	Not identified	0.9-1.7%
Smelter	7%	2%	Not identified	1-3%

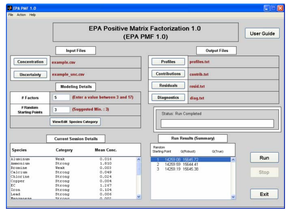
Enhancements also include development of statistics summarizing uncertainty in modeled solutions. Table shows previously published estimates of contributions for derived sources in Phoenix using 3 different receptor models. Table also shows preliminary estimates of confidence intervals for PMF-type analyses (presented by Eberly at AAAR Supersites Conference, Feb 2005).

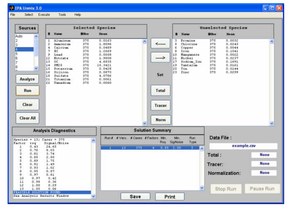
Resolving additional source types will be based on higher time-resolved data, including meteorology, and/or incorporation of species that are unique to one or a few source types. For example, to better understand sources of carbon, radiocarbon measurements can quantify the amount of carbon that is biogenic and molecular markers may help to identify narrower source types. Radiocarbon data shown to right shows that large percentage of PM2.5 carbon is biogenic (presented by Lewis at AAAR Annual Conference, Oct 2004). Research is ongoing to understand what additional species are helpful for identifying source types and can be reliably measured. Model enhancement is focusing on handling more highly time-resolved data, including cases where some species are highly-time resolved and others are integrated over several hours.

Results/Conclusions

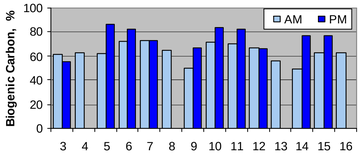
EPA has developed receptor models that can be freely distributed. Models are being used by States, Regional Planning Organizations, and academia.

Sample Screens from EPA PMF and EPA Unmix





PM2.5 Carbon (% Biogenic) - Tampa, Florida



Future Directions

EPA is encouraging the enhancement of receptor models through its STAR grants. Areas currently being researched include developing the next generation of receptor models as well as assessing the accuracy and precision of the existing models. Suggested enhancements from the STAR program and from internal research are being folded into a suite of multivariate receptor models that EPA is freely distributing to the user community.

Impact and Outcomes

Continued enhancement of receptor models and the measurements used in those models will allow air quality managers to discern more of the source types contributing to ambient PM concentrations, to quantify the level of confidence in the source type profiles and contributions, and to complement or challenge results from source-based models.

Development of GUI-based receptor models has made them easier to use. As a result, they are being used more broadly in air quality management community.

Availability of multiple GUI-based receptor models encourages comparison of results across receptor models which strengthens confidence in solutions. Characterization of uncertainty further assists policy decision makers.

Air Quality